A new Space Weather Index for Aviation

Matthias M. Meier & Daniel Matthiä

Radiation Biology, Institute of Aerospace Medicine, DLR

Outline

- Halloween Storms (28.-31. October 2003)
- Solar Particle Events in 2012
- Proposal: A New SWx Index for Aviation
- Summary

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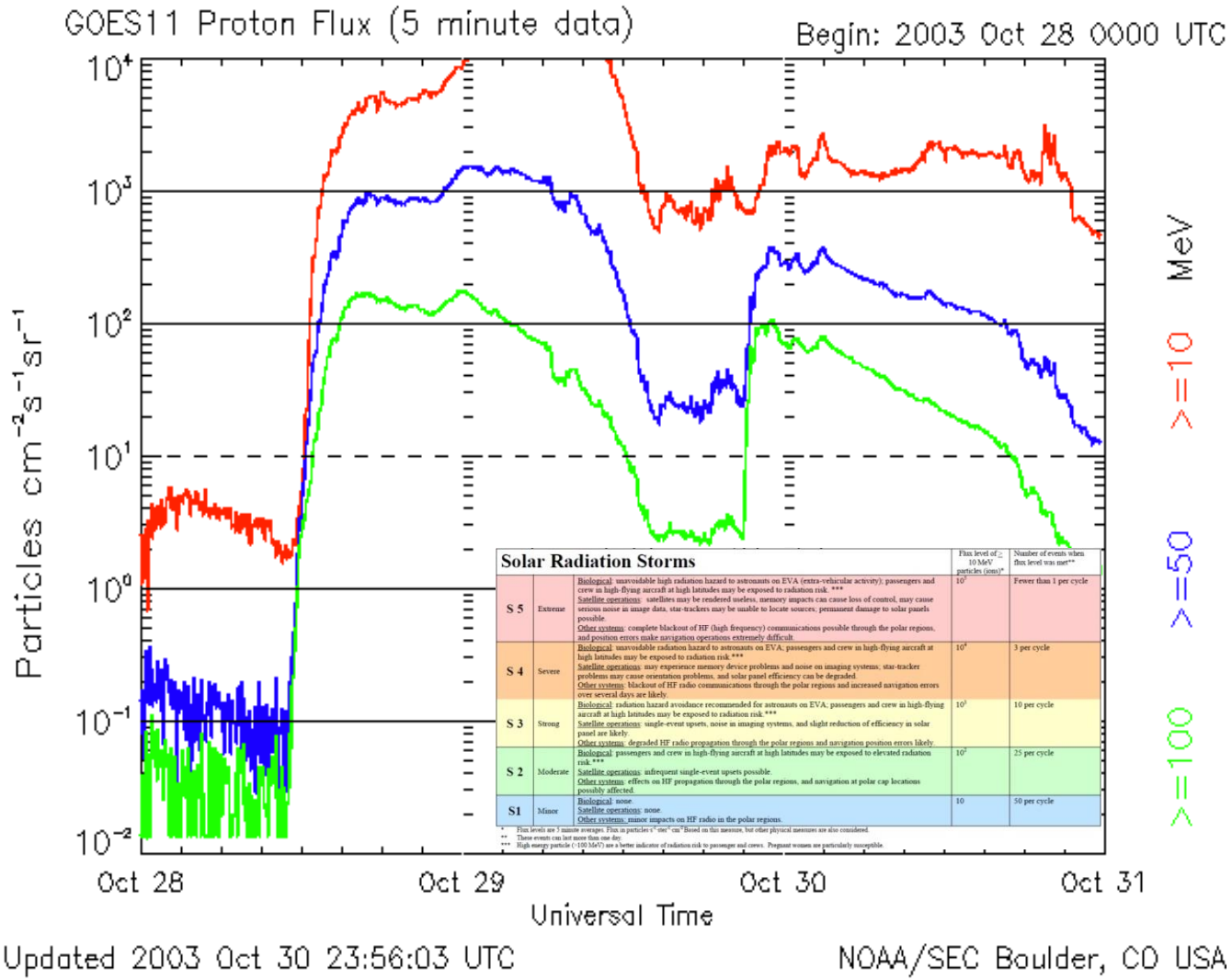
Background: October 2003

TV reported on SPEs and gave rise to public awareness all over the world.

Due to the public pressure some airlines even operated their flights at lower altitudes between 29. and 31. October.

GLE 65/66: 28.-31. October 2003



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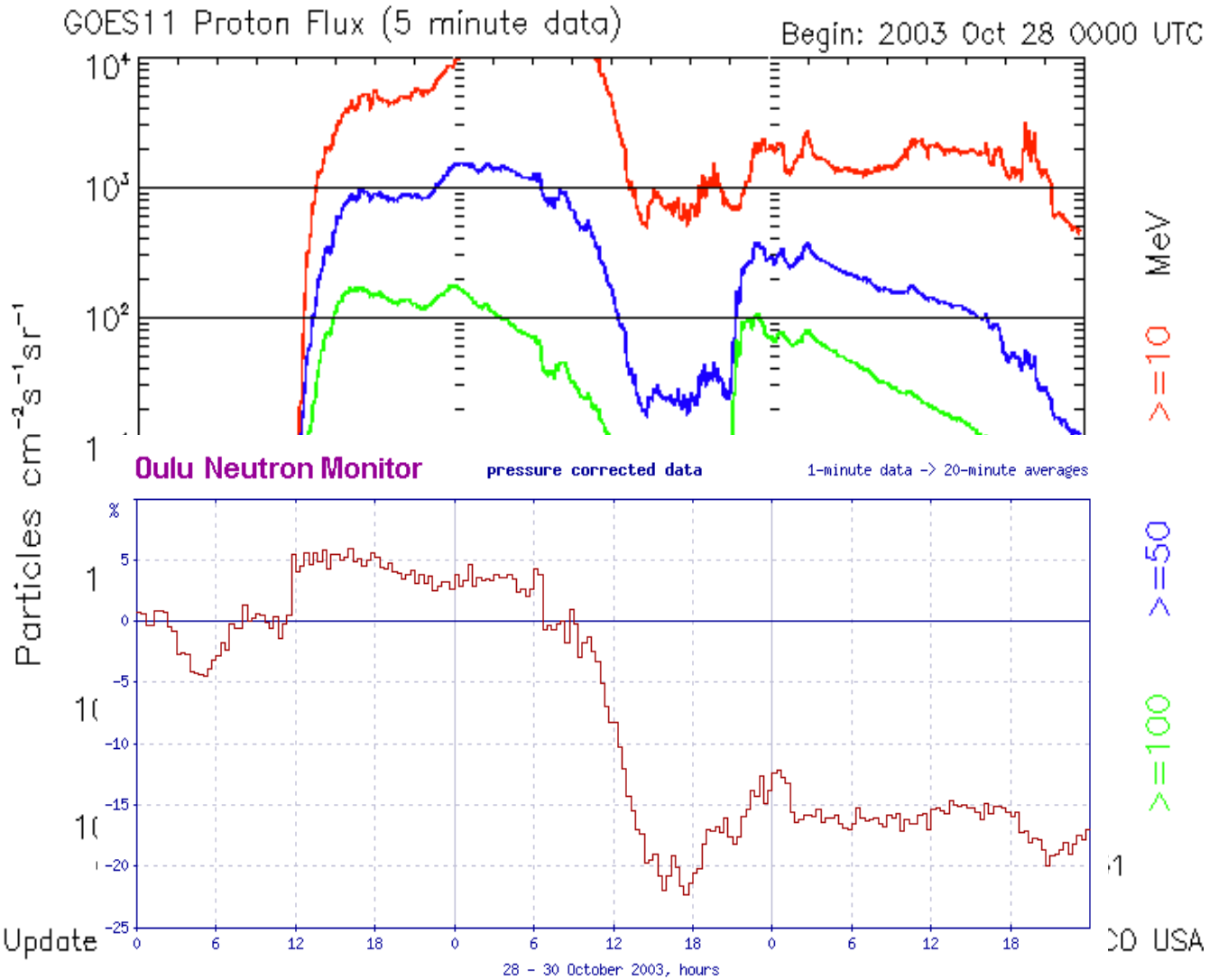
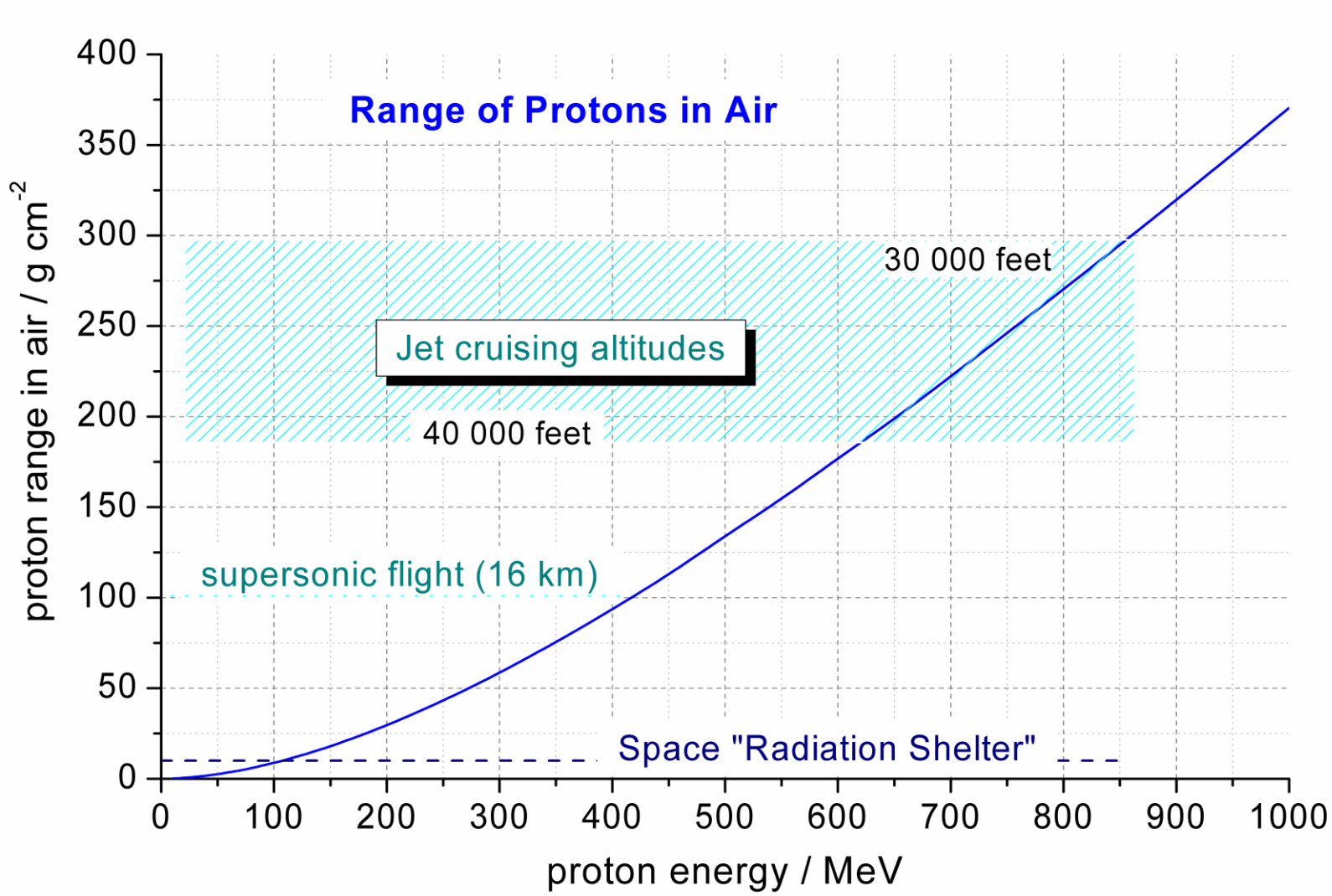
GLE 65/66: 28.-31. October 2003



Atmospheric Shielding: Range of Protons in the Atmosphere



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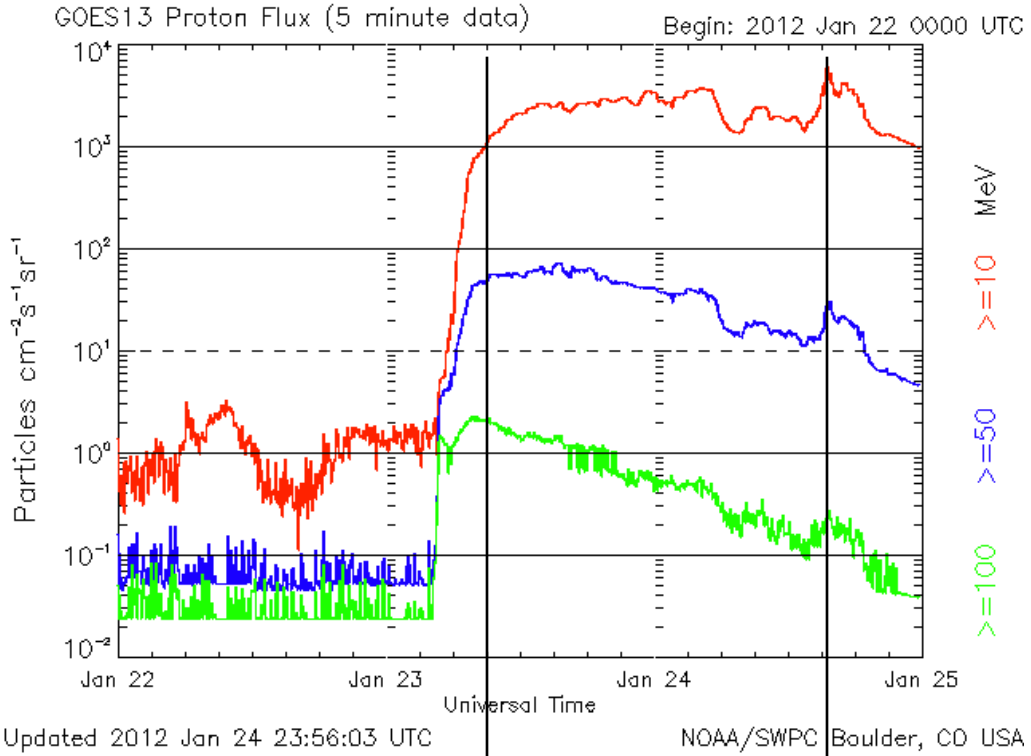
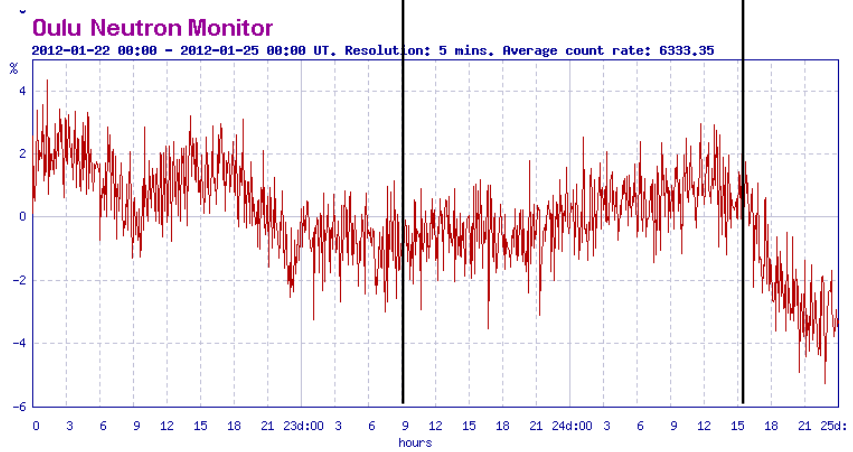
SPE: 23. Jan 2012

Sudden increase in flux of protons ≥ 10 MeV

S3 Warning

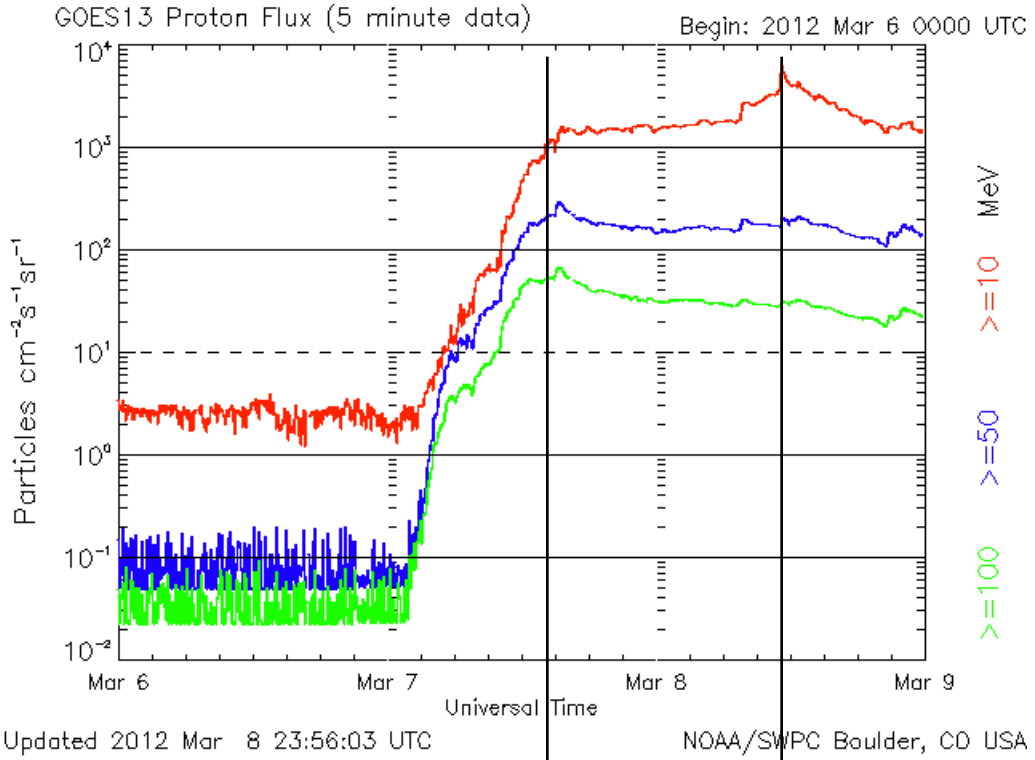
No GLE

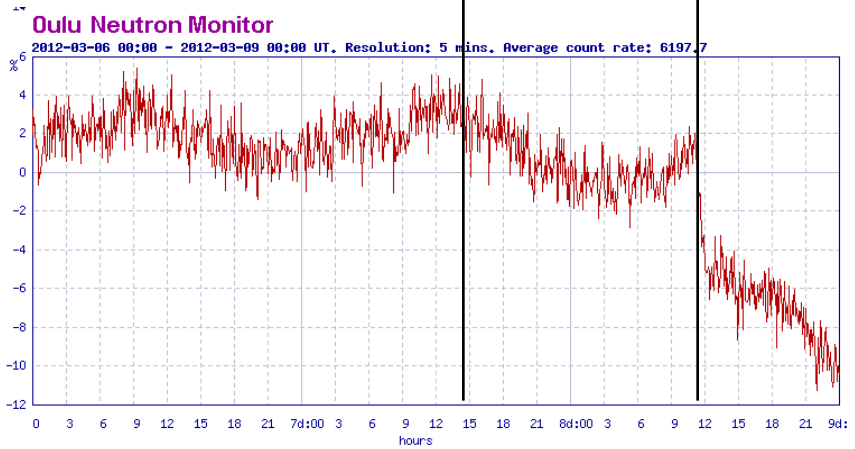




SPE: 7. Mar 2012

Slow increase in flux of protons ≥ 10 MeV





S3 Warning

No GLE

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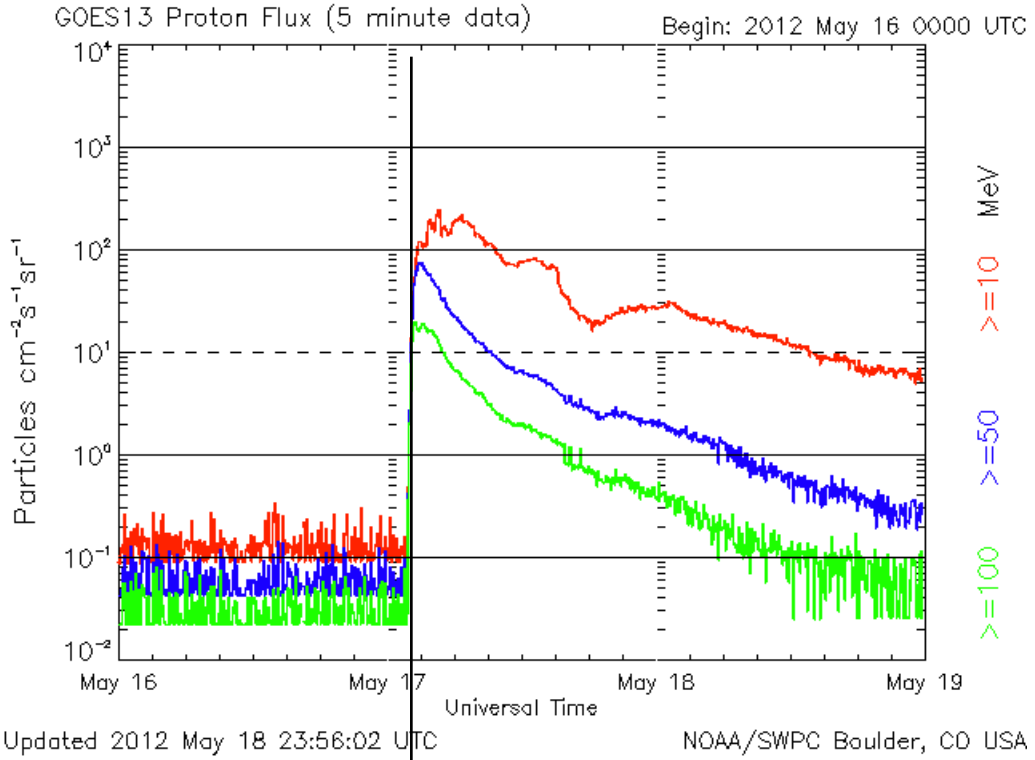
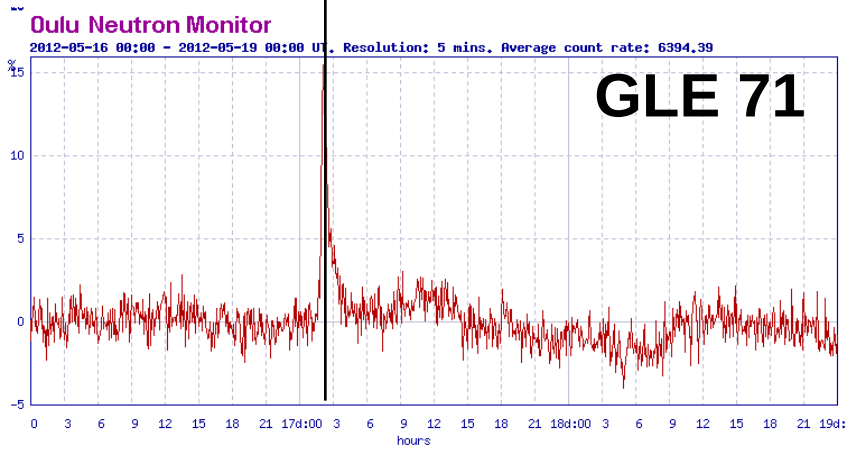
SPE: 17. May 2012

Sudden increase in flux of protons ≥ 10 MeV





S2 Warning only, but GLE 71 !

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Proposal: New SWx D-Scale with SWx Index D

Radiation Protection & Dosimetry:

Dose rates due to solar contributions at aviation altitudes can be assessed by measurements or model calculations.

General requirement:

D to be based on dose rates $\dot{E}_{sol}$.

Proposed definition:

D is the smallest natural number to satisfy the inequality:

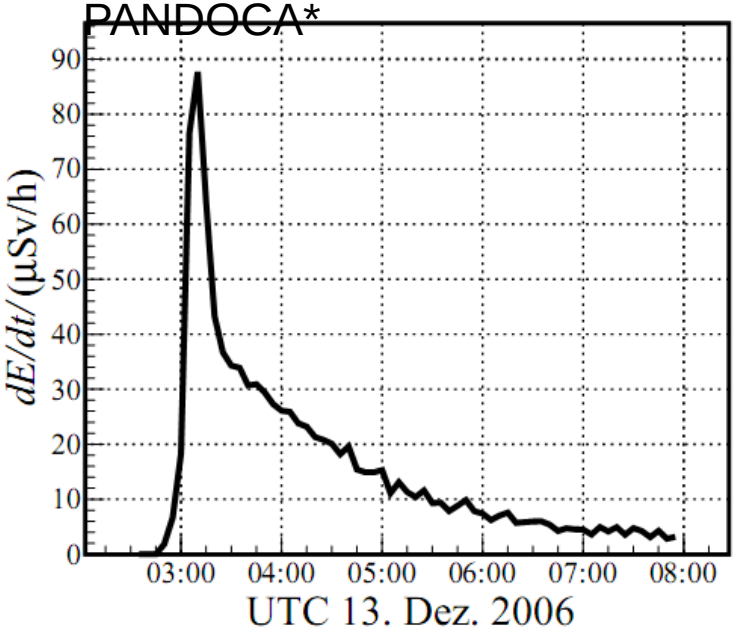
$$\dot{E}_{sol} < 5 \frac{\mu Sv}{h} \cdot 2^{D}$$

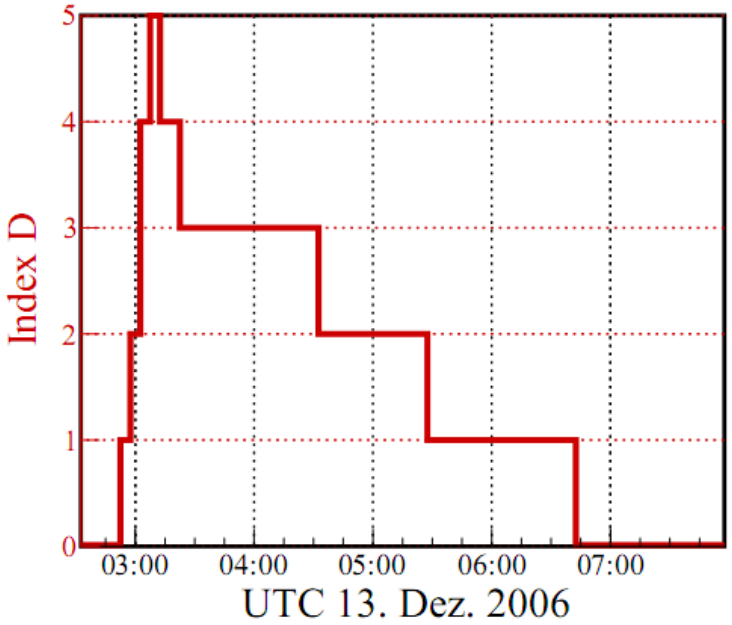
Index D	Dose rate interval [µSv/h]
0	$\dot{E}_{sol} < 5$
1	$5 \leq \dot{E}_{sol} < 10$
2	$10 \leq \dot{E}_{sol} < 20$
3	$20 \leq \dot{E}_{sol} < 40$
4	$40 \leq \dot{E}_{sol} < 80$
5	$80 \leq \dot{E}_{sol} < 160$
6	$160 \leq \dot{E}_{sol} < 320$
7	$320 \leq \dot{E}_{sol} < 640$
8	$640 \leq \dot{E}_{sol} < 1280$

…to be continued….

GLE 70, 13.12.2006: SWx Index D @ FL410, 70N, 50E

Dose assessment with PANDOCA*





* Matthiä, D., M. M. Meier, and G. Reitz (2014), Numerical calculation of the radiation exposure from galactic cosmic rays at aviation altitudes with the PANDOCA core model, Space Weather, 12, 161–171, doi:10.1002/2013SW001022.

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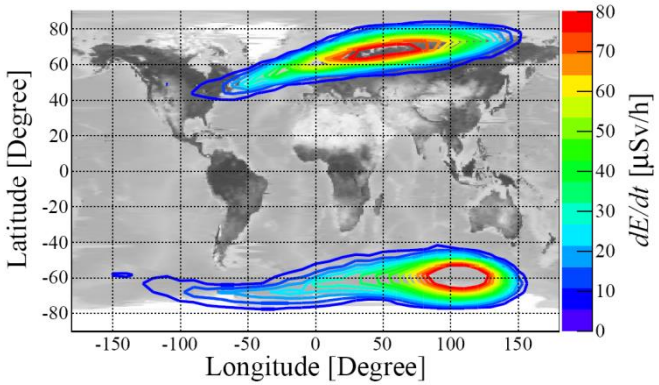
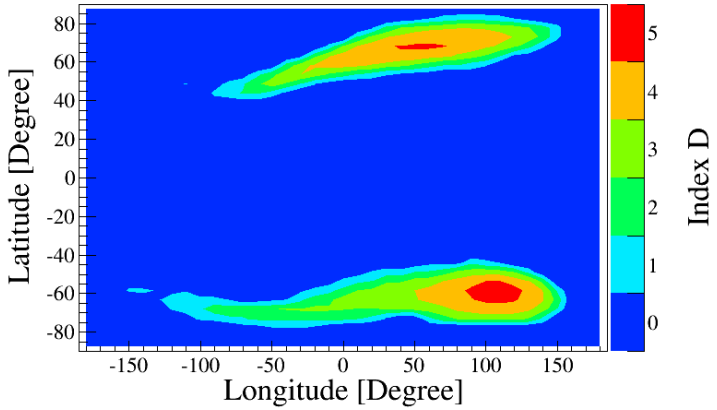
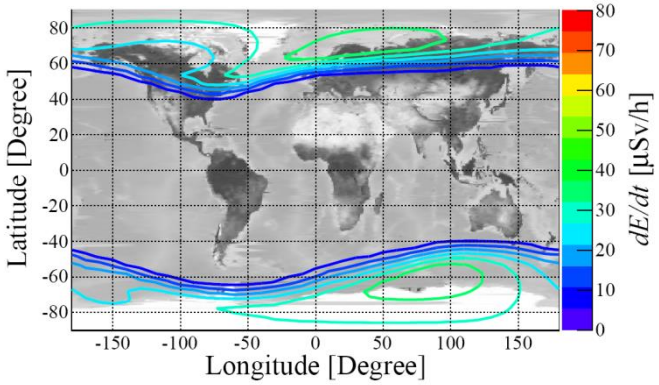
GLE 70, 13.12.2006: SWx Index D @ FL410

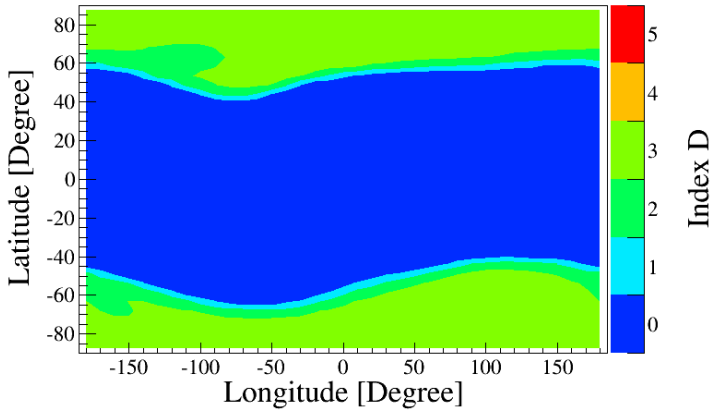
3:10 UTC





3:35 UTC





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- The NOAA S-Scale for solar radiation storms, based on the proton flux ≥ 10 MeV, is a very useful tool for many applications e.g. predicting ionospheric disturbances, radiation protection of satellites and of humans in space, etc.

- A high solar proton flux ≥ 10 MeV is a necessary, but **not** a sufficient, condition for a temporary increase in radiation exposure at aviation altitudes due to the energy spectrum of the impinging particles and the shielding of the atmosphere.

- Warnings should be based on dose rates at aviation altitudes instead of particle fluxes outside the Earth's atmosphere.

- A proposal for a corresponding warning tool is the SWx index D which is given by a 2-base logarithmic scale of dose rates due to additional solar contributions.

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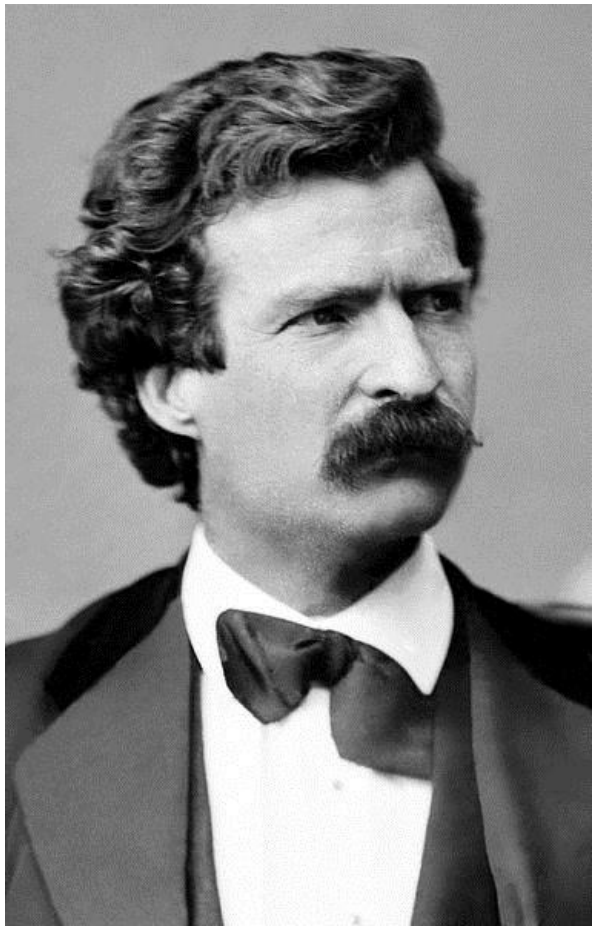

Mark Twain (1897):

“The man with a new idea is a crank…

…until the idea succeeds.“